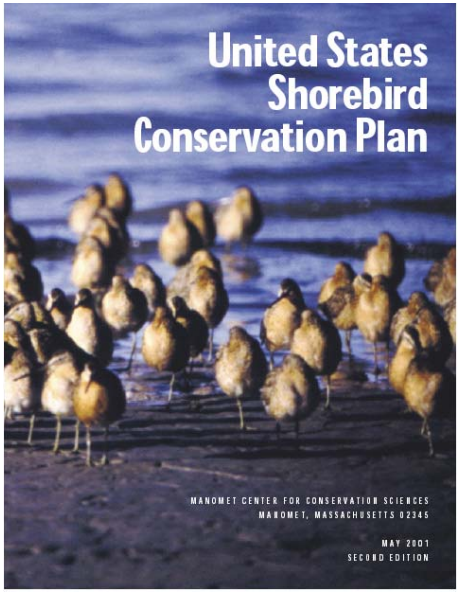
Dynamic Models of Shorebird Migration and Their Application to Shorebird Conservation in the Southeast: *An Adaptive Management Framework*

August 28, 2002

Overview

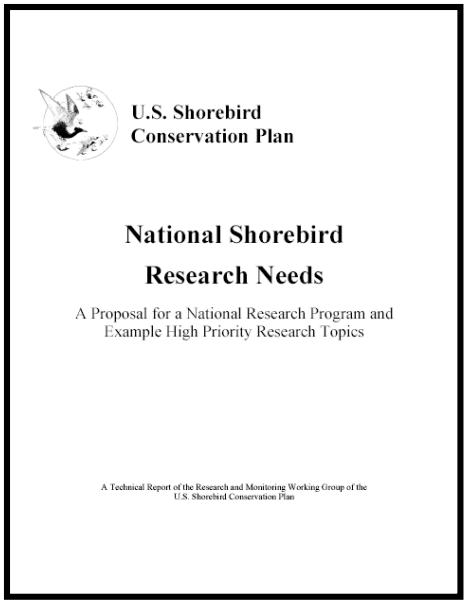
- project motivation
- goals & objectives
- proposed approach
- needs and opportunities

Motivation



- established national agenda
- spawned a regional plan for SE coastal plain
- habitat conservation necessary for successful migration through the SE

- effective habitat conservation dependent on understanding the dynamics of migration (e.g., use of stop-over sites)


U.S. Shorebird
Conservation Plan

National Shorebird
Research Needs

A Proposal for a National Research Program and
Example High Priority Research Topics

A Technical Report of the Research and Monitoring Working Group of the
U.S. Shorebird Conservation Plan

Motivation

Regional habitat requirement for spring migrating shorebirds:

$$ha = \begin{pmatrix} migratory \\ pop\ size \end{pmatrix} \times \begin{pmatrix} residency\ time \\ (days) \end{pmatrix} \times \left(\frac{food\ consumption(g)}{day} \right) \div \left(\frac{food\ availability(g)}{ha} \right)$$

- **How do the components vary over the range of spatial and temporal scales, as a function of controlled and uncontrolled environmental factors?**

- **What is the response of shorebird populations to this variation (i.e., effects on survival, reproduction, movements)?**

- **How should managers respond to these dynamics to best meet conservation goals?**

Goals

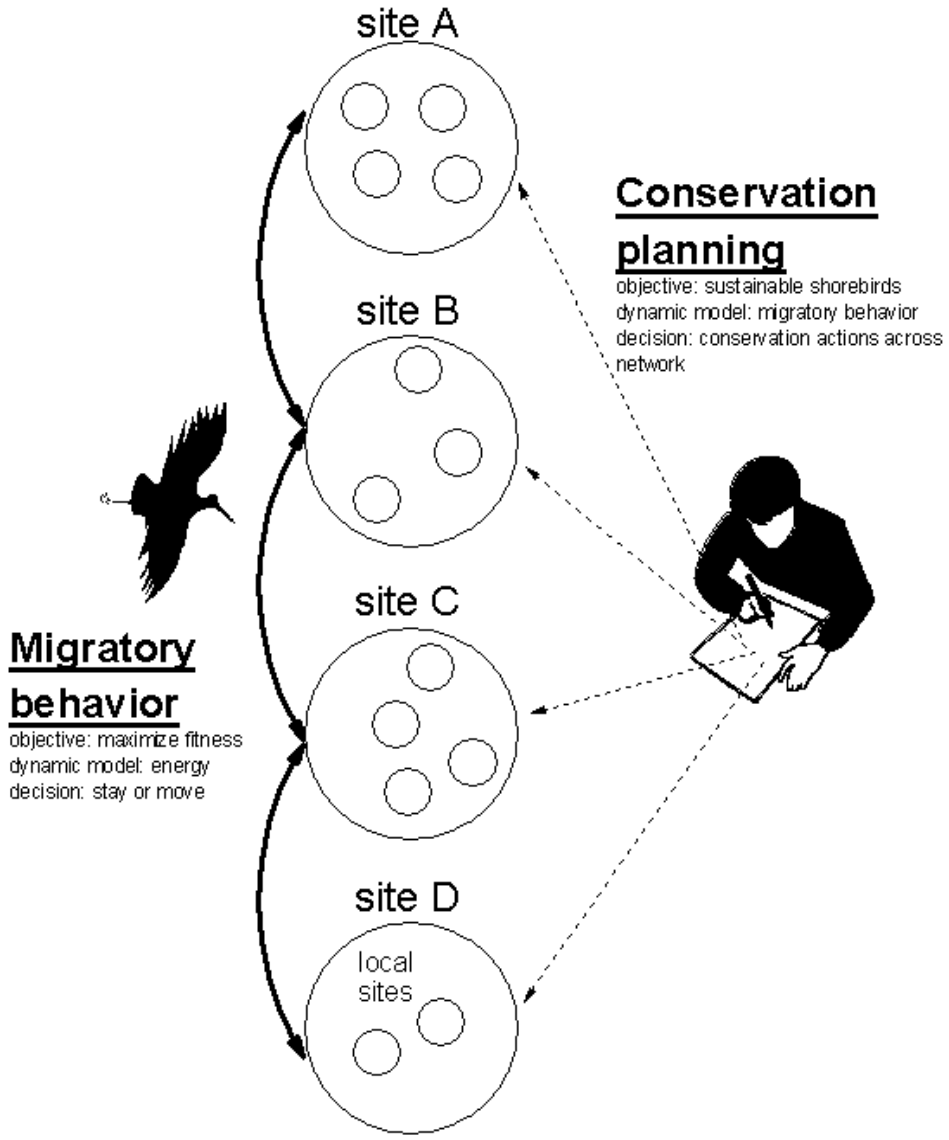
- a partnership of researchers and NWR managers in the SE
- to develop and apply decision-support tools in accordance with
- an adaptive process of shorebird-conservation planning, implementation, and evaluation

Objectives

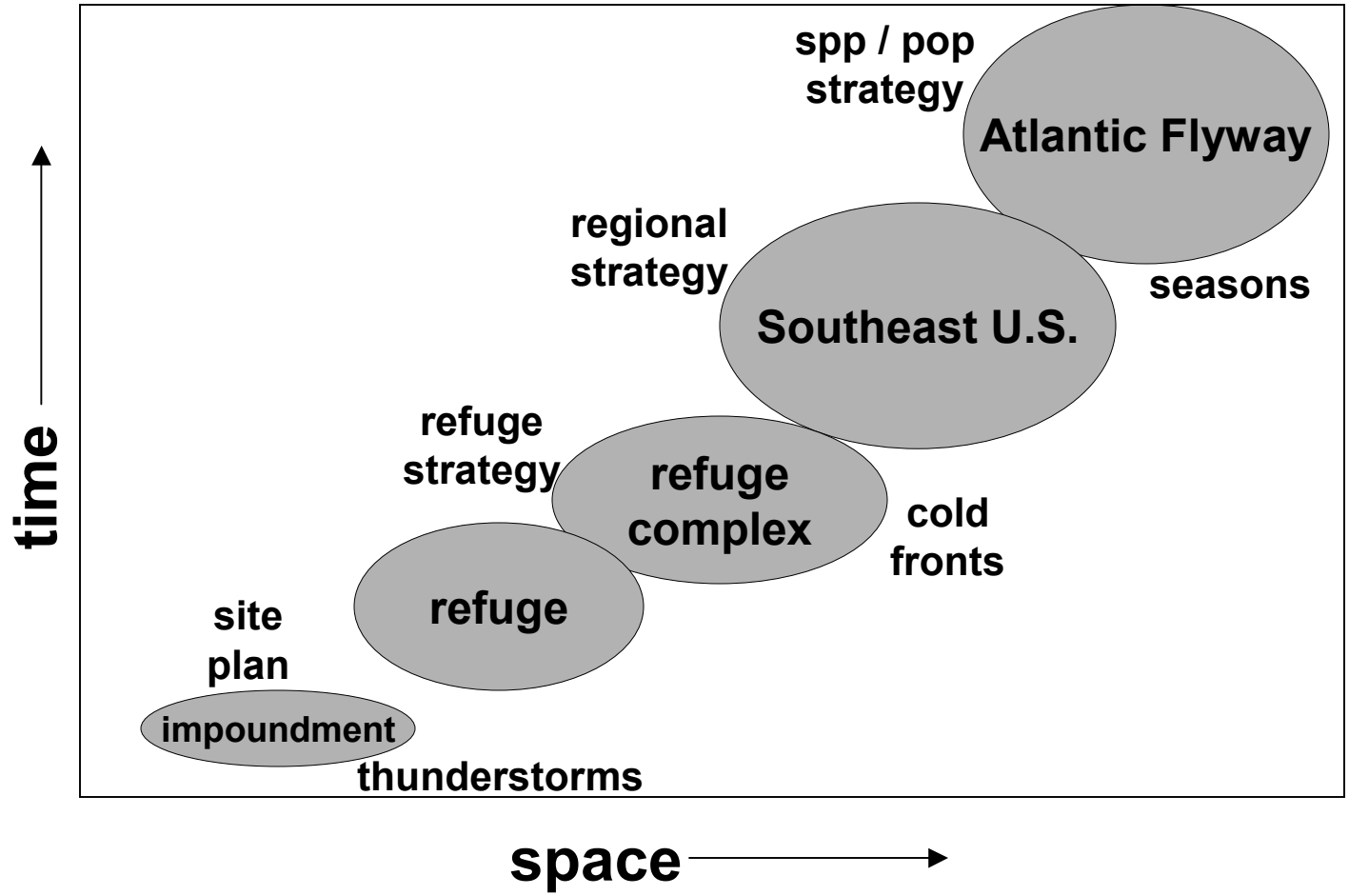
- predict (model) movements of spring-migrating shorebirds through the SE, as a function of controlled and uncontrolled environmental conditions (***the "research" piece***)

- use those predictions to support decision-making *and* evaluation by managers (***the "management" piece***)

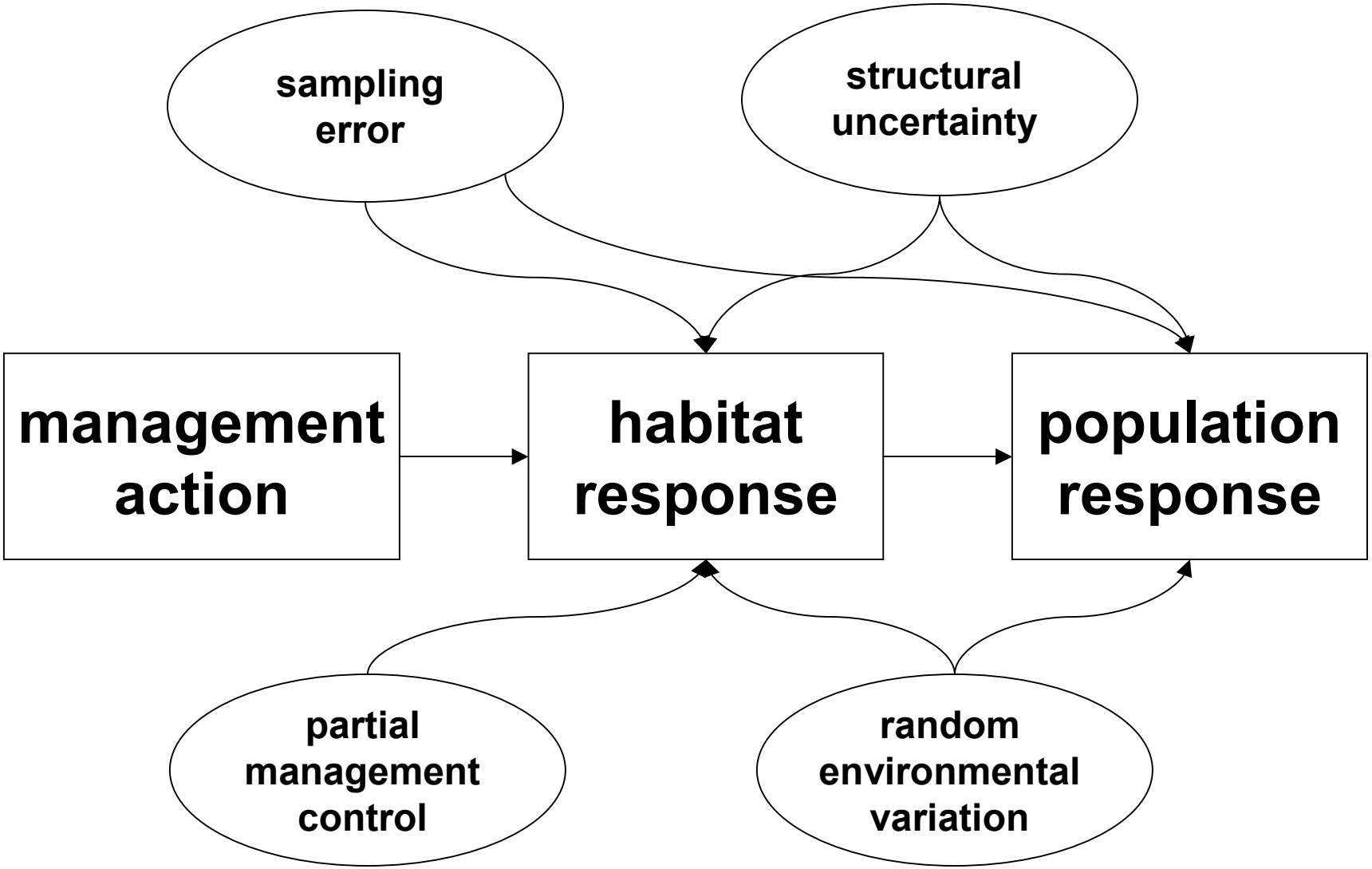
Approach


site A
site B
site C
site D
local sites
Conservation planning
objective: sustainable shorebirds
dynamic model: migratory behavior
decision: conservation actions across network
Migratory behavior
objective: maximize fitness
dynamic model: energy
decision: stay or move

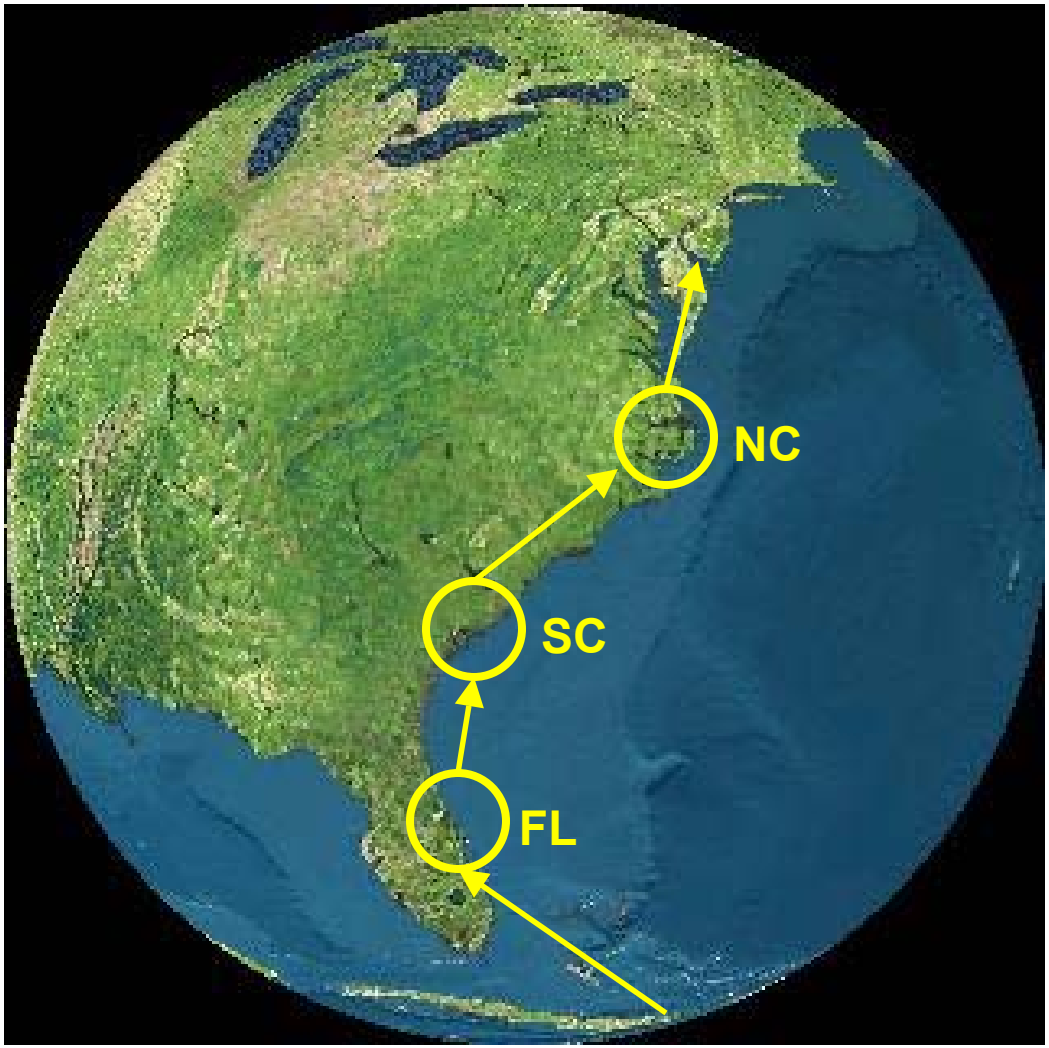
Approach


spp / pop
strategy
Atlantic Flyway
regional
strategy
Southeast U.S.
seasons
refuge
strategy
refuge
complex
cold
fronts
refuge
site
plan
impoundment
thunderstorms
time
space

Approach


sampling error
structural uncertainty
management action
habitat response
population response
partial management control
random environmental variation

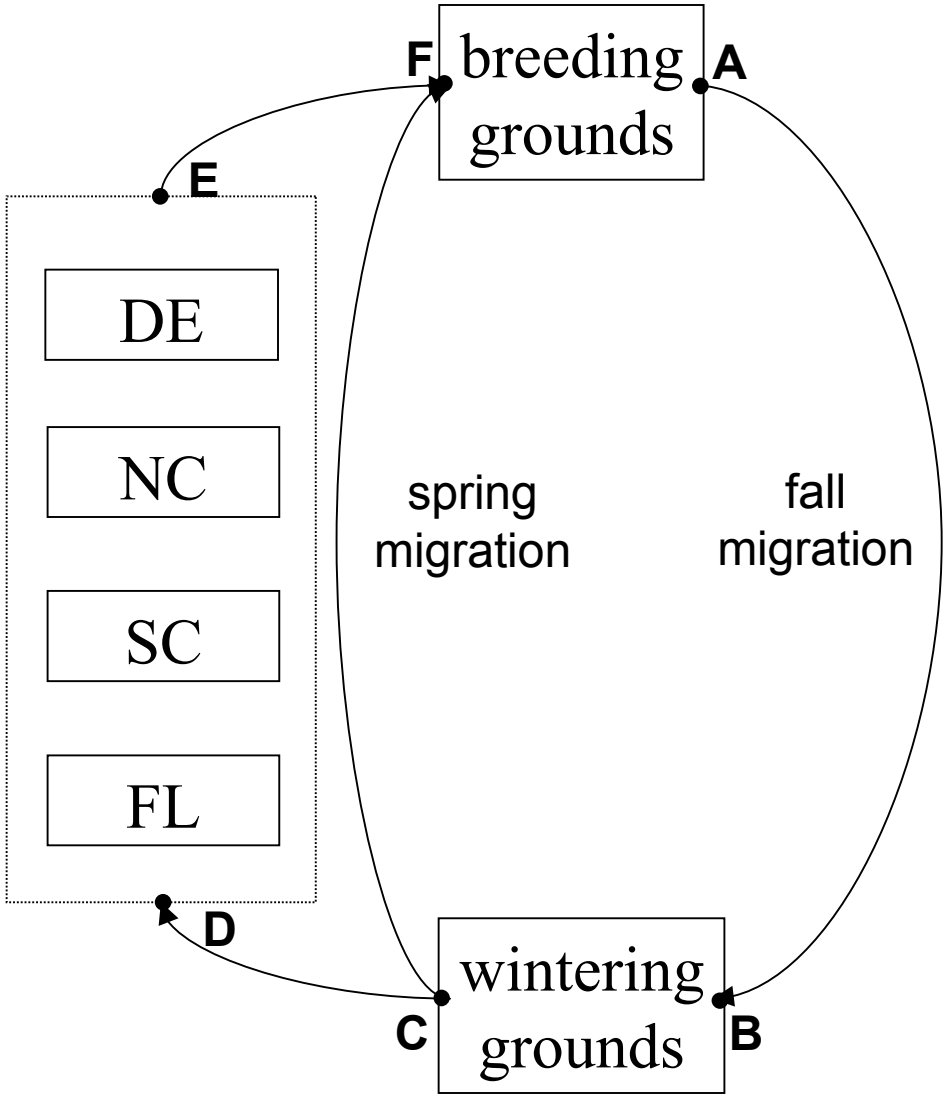
Approach



Approach

A Modeling Framework….

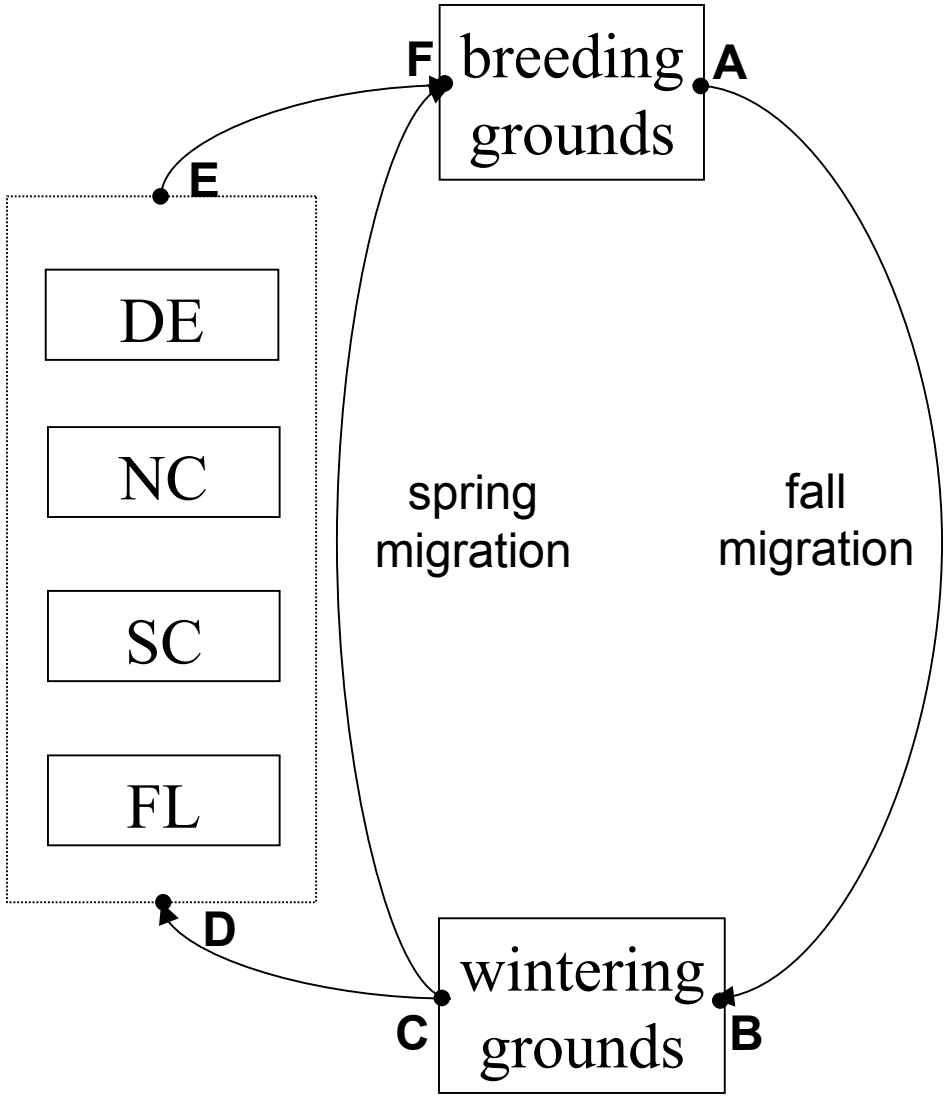
- **multiple scales of system dynamics & decision making and coherent scaling**
- **focus on refuge mgmt, but with large-scale context**
- **explicitly includes shorebird vital rates**
- **used to guide decision making and monitoring & research design**



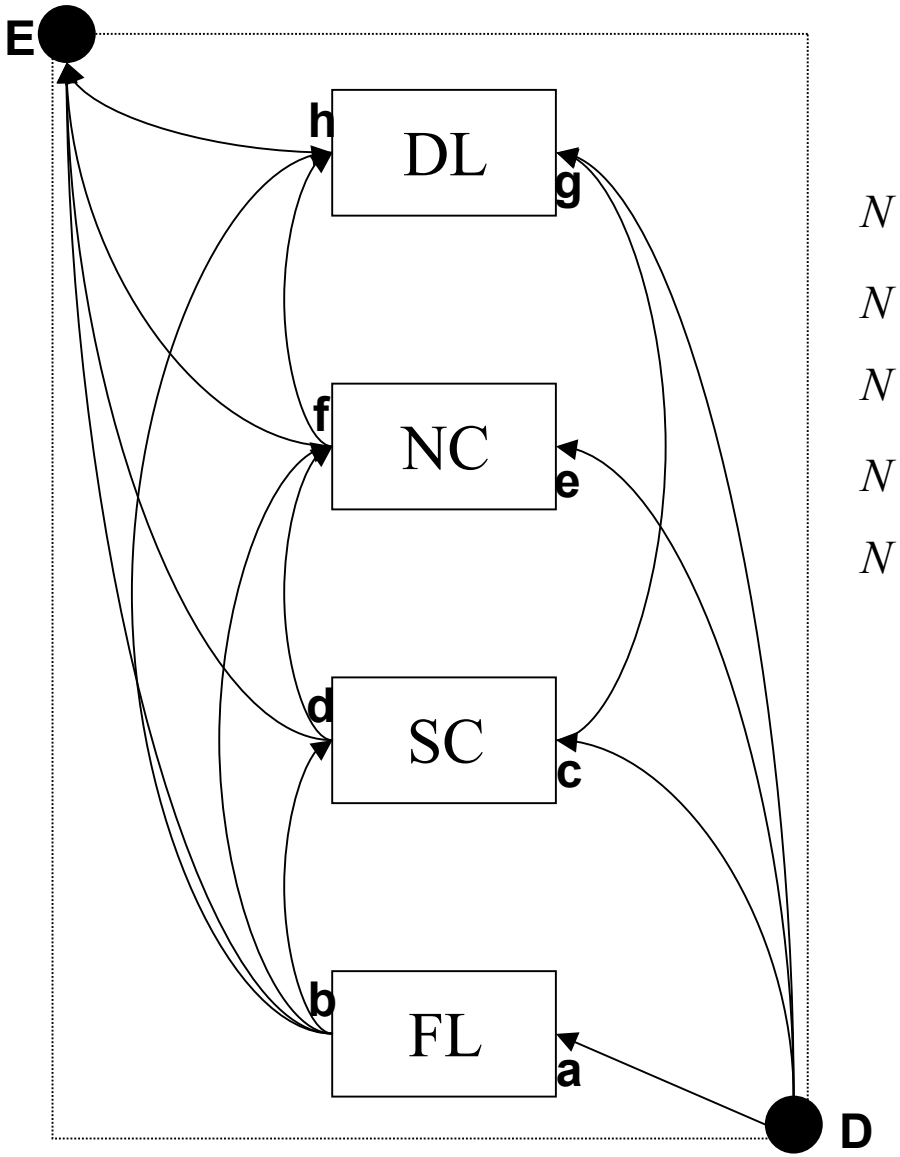
Approach

N = population size
S = survival probablity
P = recruitment rate
Ψ = movement probability
$(S\Psi)$ = transition probability

$$N^A = N^F\left(S^{FA} + P\right)$$
$$N^B = N^A S^{AB}$$
$$N^C = N^B S^{BC}$$
$$N^D = N^C\left(\Psi^{CD} S^{CD}\right)$$
$$N^E = N^D S^{DE}$$
$$N^F = N^E S^{EF} + N^C\left(1 - \Psi^{CD}\right)S^{CF}$$



Approach



$$N^a = N^d\left(\Psi^{Da} S^{Da}\right)$$

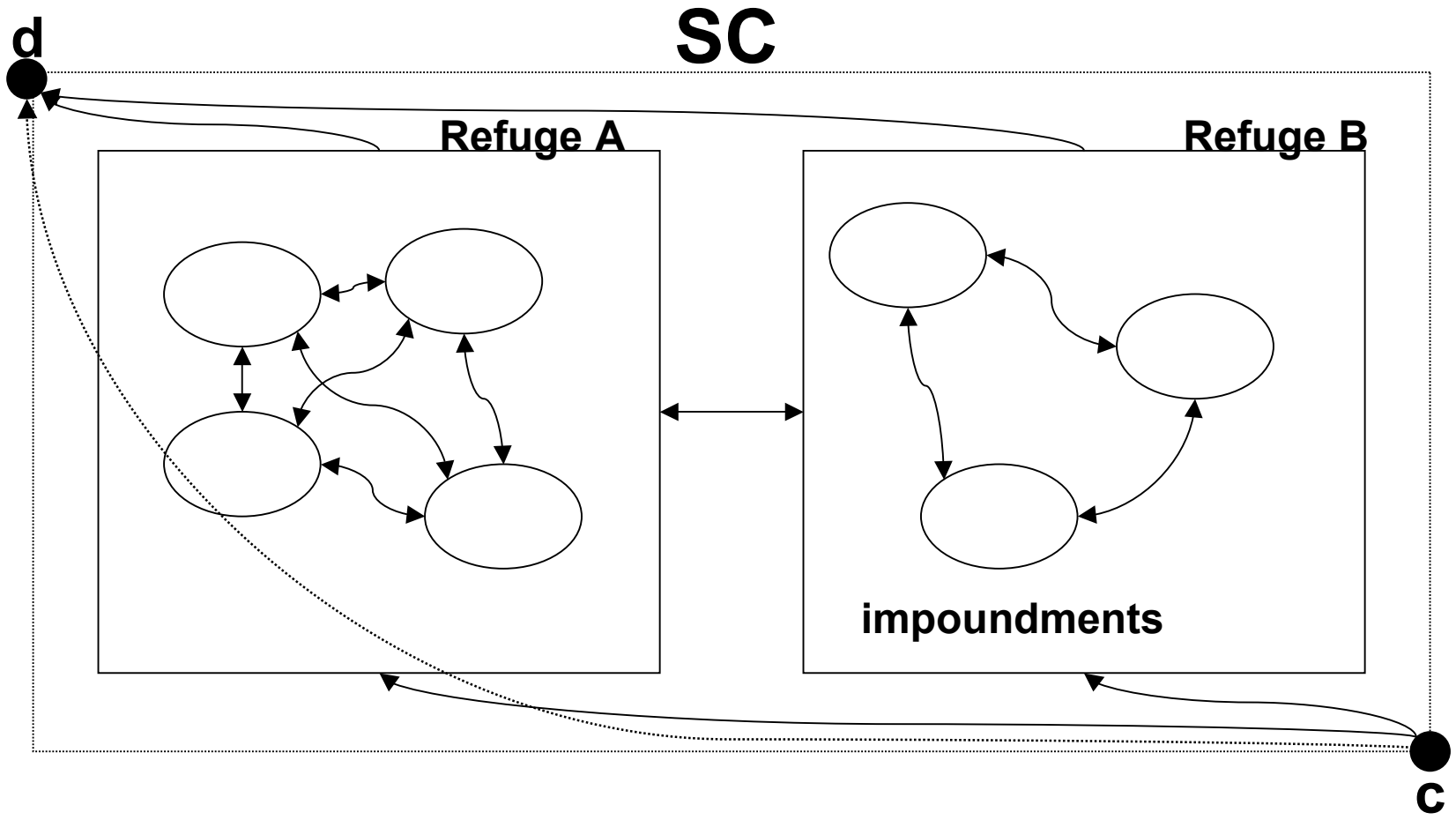
$$N^b = N^a S^{ab}$$

$$N^c = N^b\left(\Psi^{bc} S^{bc}\right) + N^D\left(\Psi^{Dc} S^{Dc}\right)$$

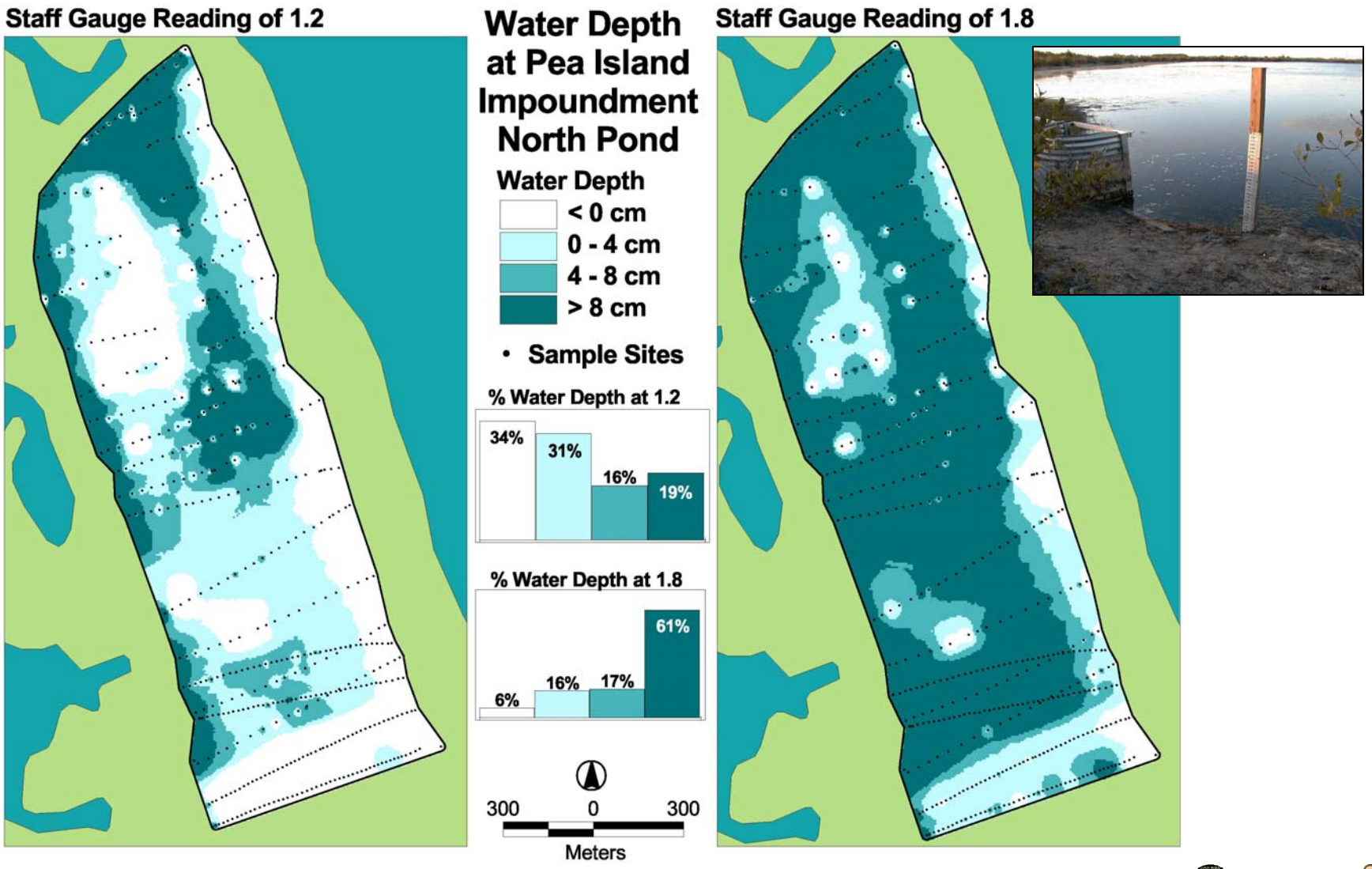
$$N^d = N^c S^{cd}$$

$$N^e = N^d\left(\Psi^{de} S^{de}\right) + N^b\left(\Psi^{be} S^{be}\right) + N^D\left(\Psi^{De} S^{De}\right)$$

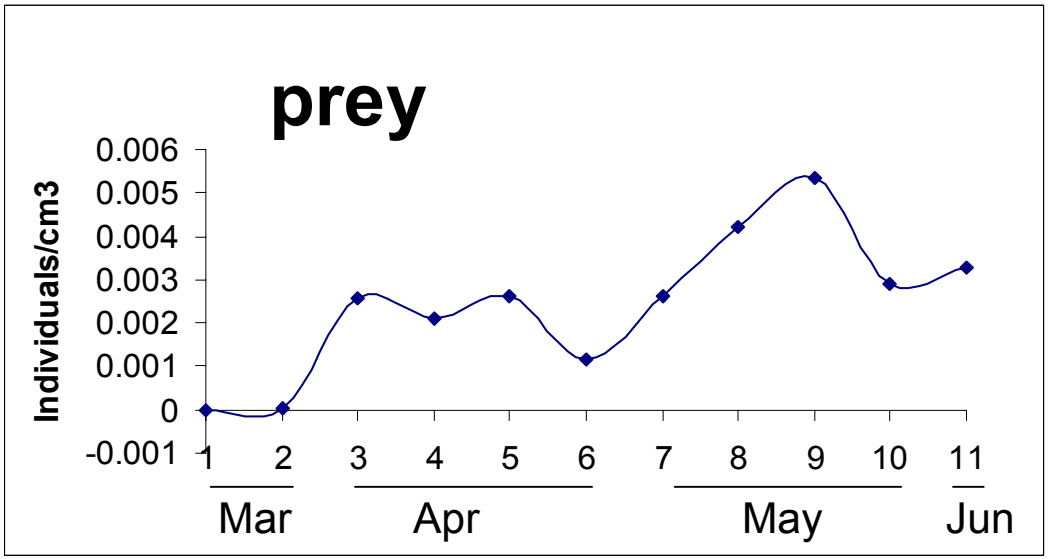
Approach

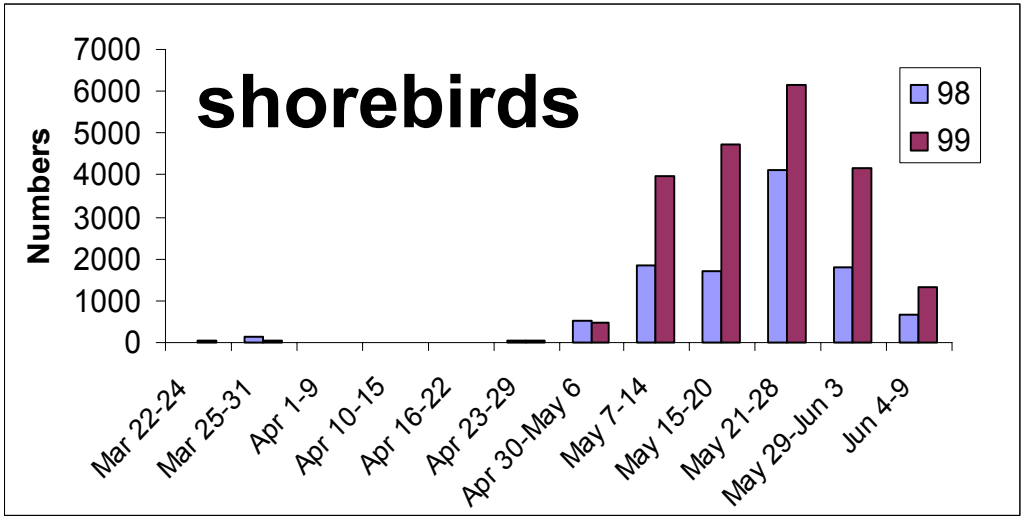


Approach


Staff Gauge Reading of 1.2
Water Depth at Pea Island Impoundment North Pond
Water Depth
< 0 cm
0 - 4 cm
4 - 8 cm
> 8 cm
• Sample Sites
% Water Depth at 1.2
34%
31%
16%
19%
% Water Depth at 1.8
6%
16%
17%
61%
300
0
300
Meters
Staff Gauge Reading of 1.8

Approach


prey
Individuals/cm3
0.006
0.005
0.004
0.003
0.002
0.001
0
-0.001
1
2
3
4
5
6
7
8
9
10
11
Mar
Apr
May
Jun


shorebirds
Numbers
7000
6000
5000
4000
3000
2000
1000
0
98
99
Mar 22-24
Mar 25-31
Apr 1-9
Apr 10-15
Apr 16-22
Apr 23-29
Apr 30-May 6
May 7-14
May 15-20
May 21-28
May 29-Jun 3
Jun 4-9

Approach

- **scale-specific management objectives**

(What are we trying to achieve at each spatio-temporal scale and how will we measure success?)

- **scale-specific management options**

(What are the array of management options available to managers at the various scales, and what are their constraints?)

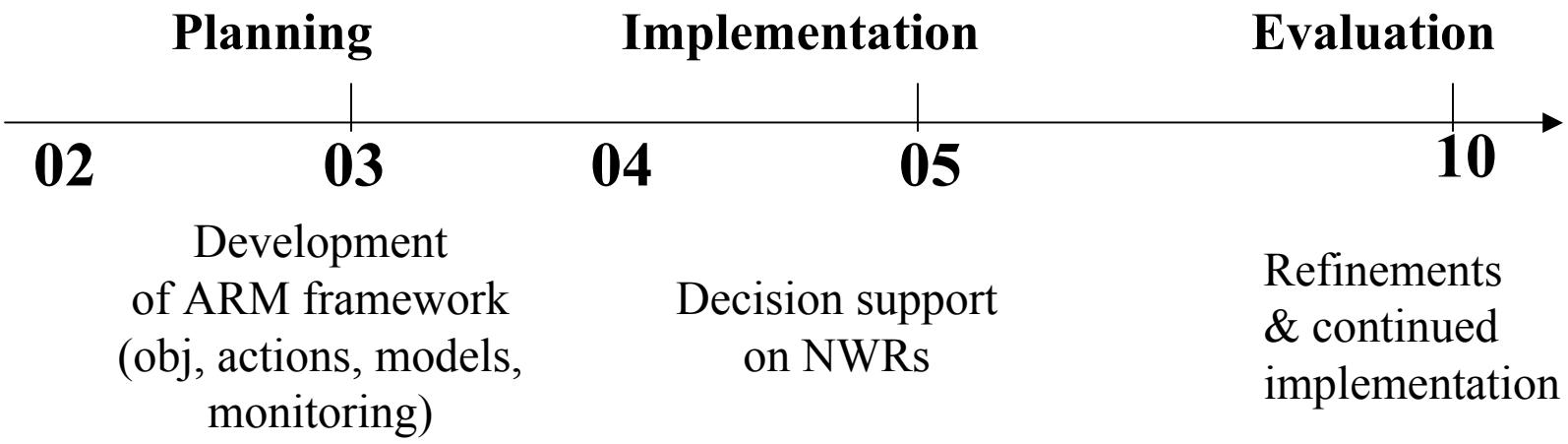
- **spatially explicit population model(s)**

(What are the key sources of uncertainty in predicting responses to management?)

- **integrated ecological monitoring & research**

(How do data-collection programs need to be designed or re-designed to help predict and verify system responses?)

Timeline


Planning
Implementation
Evaluation
02
03
04
05
10
Development of ARM framework (obj, actions, models, monitoring)
Decision support on NWRs
Refinements & continued implementation

Needs

- **USFWS - staff time & funds for project planning & coordination, technical support, implementation of mgmt actions on NWRs, and monitoring**

+

- **USGS - research on migration ecology, development of monitoring protocols and decision-support tools**

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BIG $

Opportunities

- semipalmated sandpipers, subject of on-going research in the east, have habitat requirements similar to other calidrids
- active impoundment management ongoing at key refuges
- coordinated shorebird monitoring on NWRs in the SE (SAMBI)
- distributed expertise (SEAMG, NC Coop, NCSU, PWRC) *(Nichols, Pollock, Collazo)*
- taps into a much broader regional and national effort via the U.S. Shorebird Conservation Plan

An adaptive management program of this scope will require an institutional commitment at the highest levels.

- **leadership**
- **dedication**
- **coordination**
- **staff**
- **money**
- **long-term view**

Can you help?